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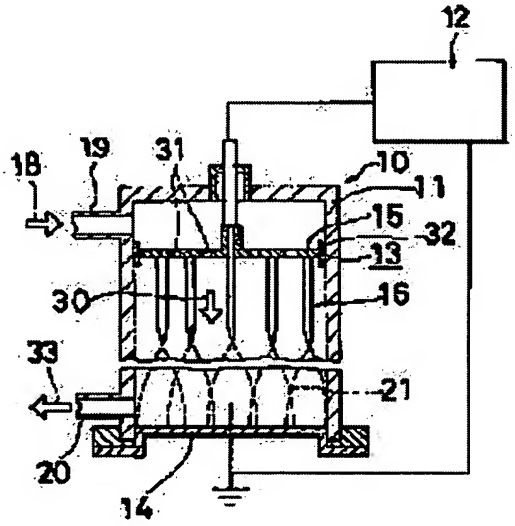
(54) EXHAUST GAS PURIFICATING APPARATUS BY PLASMA PROCESS

(57)Abstract:
PURPOSE: To provide an exhaust gas purificating apparatus by a plasma process by which a problem of contacting efficiency between a plasma and an exhaust gas and a problem of scale-up are simultaneously solved.
CONSTITUTION: A reactor 10 provided with a discharging electrode 13 and a facing electrode 14 and a high voltage pulse electric source 12 connected with both electrodes 13 and 14, are provided. A non-equilibrium plasma 21 is generated by applying a high voltage pulse between both electrodes 13 and 14. The discharging electrode 13 consists of a supporting plate 15 with the same area as that of the facing electrode 14 and a number of downward discharging needles 16 provided on the underface of the supporting plate 15. A lot of exhaust gas inlet holes 31 are provided on the supporting plate 15 and an exhaust gas flow path 30 toward the facing electrode 14 from the supporting plate 15 is in parallel to the developing direction of the plasma 21.



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CLAIMS

[Claim(s)]
[Claim 1] It has a reactor with which it comes to prepare a discharge electrode and a counterelectrode in the interior of a gas duct, and a high-voltage pulse generating power supply connected to two electrodes. Nonequilibrium plasma is generated by impressing a high-voltage pulse continuously between two electrodes. In the plasma method exhaust gas purifying facility which converts a harmful gas component in exhaust gas into a gestalt or a harmless gestalt which is easy to carry out uptake while processed exhaust gas passes through the inside of a reactor The plasma method exhaust gas purifying facility characterized by forming an emission way where it consists of a support plate and a discharge needle with which two or more tips established in a support plate sharpened, an incurrent pore of processed exhaust gas is prepared in a support plate, and a discharge electrode faces to a counterelectrode from a support plate.
[Claim 2] The plasma method exhaust gas purifying facility according to claim 1 with which a discharge electrode and a counterelectrode are prepared two or more pairs by turns, and an outflow hole of processed exhaust gas is prepared in each counterelectrode.
[Claim 3] The plasma method exhaust gas purifying facility according to claim 1 with which a discharge electrode and a counterelectrode are prepared two or more pairs by turns, and each counterelectrode consists of a mesh-like electrode.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the plasma method exhaust gas purifying facility which is one of the means to purify the harmful matter contained in the exhaust gas discharged from the boiler for a generation of electrical energy, various combustion engines, a combustion furnace, etc.
[0002]
[Description of the Prior Art] The plasma method exhaust gas purifying facility is well-known (refer to official announcement patent official report No. 500020 [Showa 63 to] official report), and explains this principle with reference to drawing 5 .
[0003] It sets to drawing 5 and is (1). The high-voltage pulse generating power supply for generating the plasma is shown, and it is (2). A wire mold discharge electrode and (3) A plate mold counterelectrode is shown. When the pulse peak voltage of 1kV - 500Kv, pulse-frequency 10HZ - 250HZ, 1 nanosecond - 10 microseconds of pulse width, and the high-voltage pulse of 100kV/nanosecond - 100v/nanosecond of build up time are continuously impressed between these two electrodes (2) and (3), it is nonequilibrium plasma (4) to inter-electrode. It generates. Exhaust gas which contains a harmful gas component in such a field (5) It is the plasma (4) when it leads. Various radicals occur.
[0004] For the injurious ingredient in exhaust gas, CO is CO2 by the reaction with this radical. SOx is SO3. NOx is NO2. It oxidizes and changes to a harmless gestalt or the gestalt which uptake is easy to be carried out. Moreover, the dioxin by which processed gas is contained in gas in the case of the exhaust gas from a refuse incinerator is decomposed and defanged. since a SOx component and an NOx component will change to solid-states, such as an ammonium sulfate and an ammonium nitrate or a calcium sulfate, and a calcium nitrate, respectively if ammonia, lime, etc. are blown into the inside of the reactor which these reactions have produced, or reactor back wash, emission gas purification is attained by preparing an electrical dust precipitator or a bag filter in back wash, and carrying out uptake of these to it.
[0005] that drawing 6 indicates the modification of an electrode to be -- it is -- high-voltage pulse generating power supply (6) from -- wire discharge electrode (7) Cylinder electrode (8) a high-voltage pulse -- continuous -- impressing -- between two electrodes (7) and (8) -- plasma (9) It is the thing of a type which makes it generate. Exhaust gas (5) Wire discharge electrode (7) Cylinder electrode (8) It passes in between.
[0006]
[Problem(s) to be Solved by the Invention] In what uses the wire mold discharge electrode shown in above-mentioned drawing 5 , and a plate mold counterelectrode Although it has the advantage that a scale-up is possible and a lot of offgas treatment can be performed by forming one electrode unit in the passage direction of exhaust gas by carrying out actual installation of many wires while lengthening a plate, and arranging two or more these electrode units in the passage direction and the direction of a right angle Since it has the feature which the plasma generates intermittently in the length direction of a wire, it has the problem which the portion of a non-dense is made to the plasma to generate, and is said that the contacting efficiency of the

plasma and exhaust gas is not good.
[0007] Moreover, in some which use the wire mold discharge electrode shown in above-mentioned drawing 6 , and a cylinder mold counterelectrode, since field strength is small, in order to process a lot of exhaust gas, the method of carrying out actual arrangement of many cylinders of the diameter of a small sum must be taken, and although the contacting efficiency of the plasma and exhaust gas is good, since wiring and an insulation of each electrode are complicated, there is a problem of not being suitable for a scale-up.
[0008] The purpose of this invention is to offer the plasma method exhaust gas purifying facility which solved the problem of the contacting efficiency of the plasma and exhaust gas, and the problem of a scale-up to coincidence.
[0009]
[Means for Solving the Problem] A reactor with which, as for the plasma method exhaust gas purifying facility by this invention, it comes to prepare a discharge electrode and a counterelectrode in the interior of a gas duct, Have a high-voltage pulse generating power supply connected to two electrodes, and nonequilibrium plasma is generated by impressing a high-voltage pulse continuously between two electrodes. In the plasma method exhaust gas purifying facility which converts a harmful gas component in exhaust gas into a gestalt or a harmless gestalt which is easy to carry out uptake while processed exhaust gas passes through the inside of a reactor It is characterized by forming an emission way where it consists of a support plate and a discharge needle with which two or more tips established in a support plate sharpened, an incurrent pore of processed exhaust gas is prepared in a support plate, and a discharge electrode faces to a counterelectrode from a support plate.
[0010] Although discharge needle's on support plate existence density is decided in consideration of dust concentration in discharge voltage, current, and exhaust gas, description of exhaust gas, etc., it is usually a 0.1-10[/square] cm degree. Although the length of a discharge needle is also designed by arbitration according to terms and conditions, such as discharge voltage and current, a value between 0.1cm and 10cm is usually adopted.
[0011] As for magnitude and number of an incurrent pore of exhaust gas which are formed in a support plate, the sum of area of an incurrent pore is decided to become more than the cross section of an exhaust gas installation pipe. A configuration of an incurrent pore may be a round hole, or may be a long hole.
[0012] It is desirable that a discharge electrode and a counterelectrode are prepared two or more pairs by turns, and an outflow hole of processed exhaust gas is prepared in each counterelectrode. Magnitude and number of exhaust gas outflow holes are decided like magnitude of an emission ON hole and a number which are formed in a support plate of a discharge electrode.
[0013] A discharge electrode and a counterelectrode are prepared two or more pairs by turns, and you may make it each counterelectrode consist of a mesh-like electrode.
[0014]
[Function] In case the plasma method exhaust gas purifying facility by this invention adjusts and scales up the density of a discharge needle so that the portion of a non-dense may not be made to the plasma since a discharge electrode consists of a support plate and a discharge needle with which two or more tips established in the support plate sharpened, it enlarges area of a support plate. Moreover, the incurrent pore of exhaust gas is prepared in a support plate, the progress direction of the plasma generated since the emission way which faces to a counterelectrode from a support plate is formed becomes parallel to the flow of exhaust gas, and since the progress speed of the plasma to generate is quicker than the flow of exhaust gas, exhaust gas contacts the plasma in multistage.
[0015]
[Example] The example of this invention is explained with reference to a drawing below.
[0016] Drawing 1 shows the 1st example of the plasma method exhaust gas purifying facility by this invention, and drawing 2 shows the concept of the electrode for plasma generating.
[0017] The plasma method exhaust gas purifying facility of the 1st example is equipped with the high-voltage pulse power supply (12) connected with the reactor (10) with which it comes to

prepare a discharge electrode (13) and a counterelectrode (14) in the interior of a gas duct (11) two electrodes (13) and (14).
[0018] The introductory pipe (19) of processed exhaust gas (18) is prepared in the upper limit section of the left side wall of a reactor (10), and the discharge pipe (20) of processed exhaust gas (33) is prepared in this lower limit section. A discharge electrode (13) is arranged at a level with the upper part of a reactor (10), and the upper part of a discharge electrode (13) is made with exhaust gas installation space. The counterelectrode (14) forms the bottom wall of a reactor (10), and the discharge electrode (13) and the reactor (10) are electrically insulated by the ceramic for an insulation (32).
[0019] A counterelectrode (14) is a plate mold and a discharge electrode (13) consists of a support plate (15) of the same area as a counterelectrode (14), and many downward discharge needles (16) formed in the support plate (15) inferior surface of tongue. Many emission ON holes (31) are prepared in the support plate (15) of a discharge electrode (13), and, thereby, the emission way (30) which faces to a counterelectrode (14) from a support plate (15) is formed in it.
[0020] A discharge electrode (13) consists of a good conductive material, and the point of a discharge needle (16) has the diameter of 0.1cm - 1cm. It is more desirable for the point to be sharp although the diameter of the end face section of a discharge needle (16) is arbitrary. Field strength can be enlarged by making the point of a discharge needle (16) into the configuration where it sharpened. Although discharge needle's (16) on support plate (15) existence density is decided in consideration of the dust concentration in discharge voltage, current, and processed exhaust gas (18), the description of processed exhaust gas (18), etc., it is usually a 0.1 - 10 [/square] cm degree. Although the length of a discharge needle (16) is also designed by arbitration according to terms and conditions, such as discharge voltage and current, the value between 0.1cm and 10cm is usually adopted.
[0021] As for the magnitude and the number of emission ON holes (31) which are formed in a support plate (15), the sum of the area of an incurrent pore (31) is decided to become more than the cross section of an emission close pipe (19). By doing in this way, in case exhaust gas (18) passes an emission ON hole (31), it is prevented that resistance loss occurs. The configuration of an incurrent pore (31) may be a round hole, or may be a long hole.
[0022] The processed exhaust gas (18) containing NOx and SOx enters into a reactor (10) from an inflow pipe (19), and passes along the emission ON hole (31) of a support plate (15), it flows the emission way (30) between two electrodes (13) and (14) downward in parallel with a discharge needle (16), and defanging processing is carried out. Exhaust gas [finishing / processing] (33) is discharged out of a reactor (10) from an outflow pipe (20).
[0023] Between a discharge electrode (13) and a counterelectrode (14), nonequilibrium plasma (pulse streamer corona) (21) has occurred by impressing a high-voltage pulse. Processed exhaust gas (18) contacts the plasma (21), while passing through the emission way (30) in a reactor (10), and thereby, various radicals generate it in exhaust gas. NOx and SOx in exhaust gas oxidize by this radical, and it is NO2. SO3 It changes. Thus, the processed exhaust gas (33) containing the harmful gas component which changed moves to the uptake section (illustration abbreviation) prepared in back wash through the outflow pipe (20). Since the progress direction of the plasma (21) to generate is parallel to the direction of an emission way (30), exhaust gas (18) and the plasma (21) contact continuously, and its processing effectiveness improves. Furthermore, since the progress speed of the plasma (21) to generate is quicker than the flow of the exhaust gas in an emission way (30), the plasma (21) is contacted in multistage, dissociation takes place, and processing effectiveness of exhaust gas processed improves further.
[0024] although not illustrated to drawing 1 -- NO2 And SO3 etc. -- since gas reacts very well with alkaline material, for example, ammonia, or slaked lime, after it comes out of a duct, it is removed out of gas by the following methods in the uptake section.
[0025] ** By blowing ammonia into gas, make an ammonium nitrate and an ammonium sulfate generate and carry out uptake with the electrostatic precipitator or bag filter further prepared in back wash.
[0026] ** By blowing slaked lime into gas, make a calcium nitrate and a calcium sulfate generate

and carry out uptake with the electrostatic precipitator or bag filter further prepared in back wash.
[0027] ** Lead to wet ******, and lime slurry or a sodium-hydroxide aqueous solution washes, and remove out of gas.
[0028] In addition, it sets above and is NOx in exhaust gas NO2 Although the example to carry out was explained, NOx is N2 by conditions. It may become. It is N2 when reducing agents, such as ammonia and a hydrocarbon, are made to live together in exhaust gas. Conversion becomes remarkable. In this case, although a reactor is made passed after blowing a reducing agent into reverse previously as the above-mentioned example, the effect by this invention does not change even in this case.
[0029] Drawing 3 shows the 2nd example of the plasma method exhaust gas purifying facility by this invention. In the plasma method exhaust gas purifying facility of the 2nd example, the discharge electrode (13) and the counterelectrode (14) are prepared two or more pairs by turns in the reactor (10). A discharge needle (16) is formed in both sides of the support plate (15) of a discharge electrode (13), and each electrode of both ends is made with the counterelectrode (14). Many emission ON holes (31) are prepared as well as the 1st example at the support plate (15) of a discharge electrode (13), and many processed exhaust gas outflow holes (32) are prepared in the counterelectrode (14).
[0030] The discharge electrode (13) and the reactor (10) outer wall are electrically insulated by the insulating material made from a ceramic. The lead wire (17) which connects a high-pressure pulse power supply (12), each electrode (13), and (14) is similarly insulated with the reactor (10) outer wall.
[0031] The magnitude and the number of outflow holes (32) which are formed in a counterelectrode (14) are decided like the magnitude of an incurrent pore (31) and the number which are formed in the support plate (15) of a discharge electrode (13).
[0032] With the equipment of the 2nd example, the processed exhaust gas (18) introduced into the reactor (10) from the introductory pipe (19) A connoisseur is passed [hole / exhaust gas outflow / of each counterelectrode (14) / the emission ON hole (31) of the support plate (15) of each discharge electrode (13), and / (32)] in parallel with a discharge needle (16) in between two electrodes (13) and (14) one by one, and defanging processing is carried out while passing along between all electrodes (13) and (14). Exhaust gas [finishing / processing] (33) is discharged out of a reactor (10) from a discharge pipe (20).
[0033] Therefore, the time amount to which processed exhaust gas (18) contacts the plasma (21) becomes very long, and defanging processing of the exhaust gas is carried out very finely from installation before discharge.
[0034] Drawing 4 shows the concept of the electrode for plasma generating of the 3rd example of the plasma method exhaust gas purifying facility by this invention.
[0035] The electrode for plasma generating of the plasma method exhaust gas purifying facility of the 3rd example consists of the same discharge electrode (13) as the 1st example, and a mesh-like counterelectrode (34). And the emission way (30) which faces to a counterelectrode (34) from the support plate (15) of a discharge electrode (13) is formed. These electrodes (13) and two or more pairs of (33) are prepared by turns as well as the plasma method exhaust gas purifying facility of the 2nd example shown in drawing 3 .
[0036] It is discharged, after processed exhaust gas's (18)'s having between the emission ON hole (31) of the support plate (15) of each discharge electrode (13), and the meshes of each counterelectrode (33) passed, passing a connoisseur in parallel with a discharge needle (16) in between two electrodes (13) and (33) one by one and passing along between all electrodes (13) and (33) by the equipment of the 3rd example. Therefore, the time amount to which exhaust gas (18) contacts the plasma (21) becomes very long, and defanging processing of the exhaust gas is carried out very finely from installation before discharge.
[0037]
[Effect of the Invention] Since according to the plasma method exhaust gas purifying facility of this invention the density of a discharge needle can be adjusted so that the portion of a non-dense may not be made to the plasma, the contacting efficiency of the plasma and exhaust gas

is good. And since the progress direction of the plasma to generate contacts the plasma in [exhaust gas] multistage in parallel with the flow of exhaust gas, the contact time of exhaust gas and the plasma is acquired enough, and processing effectiveness improves. Moreover, since what is necessary is just to enlarge area of a support plate in case it scales up, a scale-up is made easily.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the vertical cross section showing roughly the plasma method exhaust gas purifying facility by this invention.
[Drawing 2] It is the perspective diagram showing the concept of the electrode for plasma generating in this equipment.
[Drawing 3] It is a notch **** perspective diagram about the part which shows roughly other examples of the plasma method exhaust gas purifying facility by this invention.
[Drawing 4] It is the perspective diagram showing the concept of other examples of the electrode for plasma generating.
[Drawing 5] It is the perspective diagram showing the concept of the electrode for plasma generating in the conventional plasma method exhaust gas purifying facility.
[Drawing 6] It is the perspective diagram showing the concept of the electrode for plasma generating in the conventional plasma method exhaust gas purifying facility.
[Description of Notations]
(10) Reactor
(11) Gas duct
(12) High-pressure pulse power supply
(13) Discharge electrode
(14) (34) Counterelectrode
(15) Support plate
(16) Discharge needle
(18) Exhaust gas
(21) Plasma
(30) Emission way
(31) Emission ON hole
(32) Exhaust gas outflow hole

[Translation done.]

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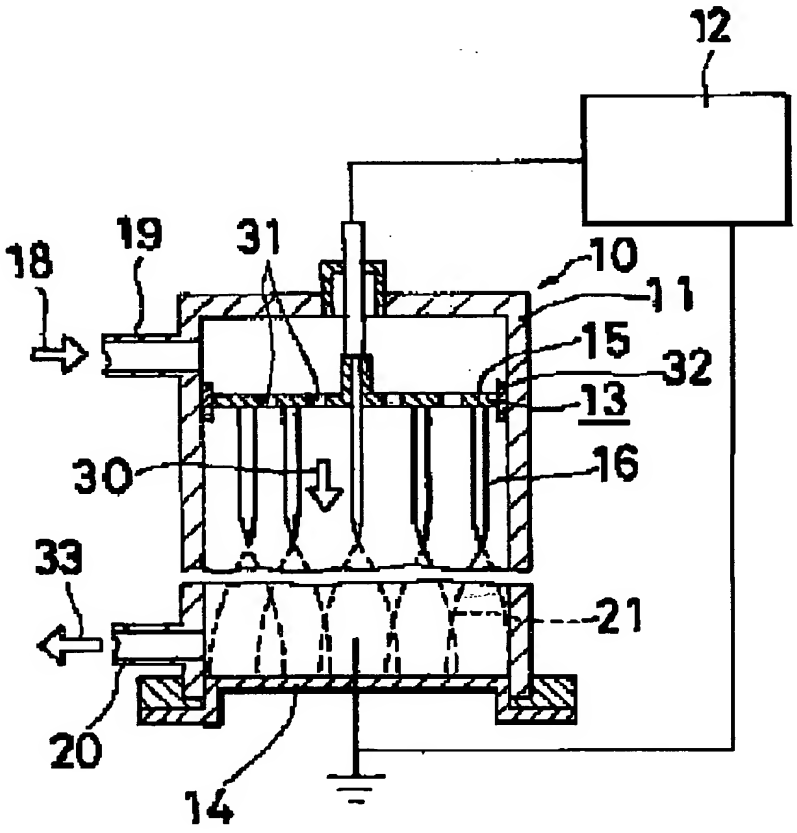
(54) EXHAUST GAS PURIFICATING APPARATUS BY PLASMA PROCESS

(57) Abstract:

PURPOSE: To provide an exhaust gas purificating apparatus by a plasma process by which a problem of contacting efficiency between a plasma and an exhaust gas and a problem of scale-up are simultaneously solved.

CONSTITUTION: A reactor 10 provided with a discharging electrode 13 and a facing electrode 14 and a high voltage pulse electric source 12 connected with both electrodes 13 and 14, are provided. A non-equilibrium plasma 21 is generated by applying a high voltage pulse between both electrodes 13 and 14. The discharging electrode 13 consists of a supporting plate 15 with the same area as that of the facing electrode 14 and a number of downward discharging needles 16 provided on the underface of the supporting plate 15. A lot of exhaust gas inlet holes 31 are provided on the supporting plate 15 and an exhaust gas flow path 30 toward the facing electrode 14 from the supporting plate 15 is in parallel to the developing direction of the plasma 21.



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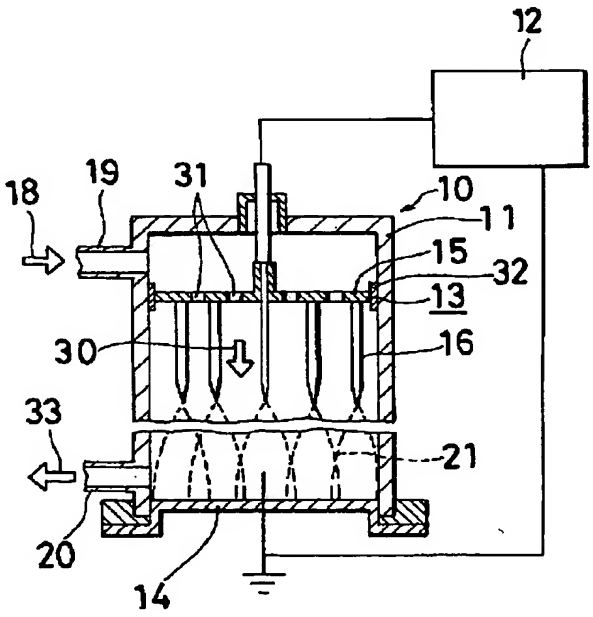
(54)【発明の名称】　プラズマ法排ガス浄化装置

(57)【要約】

【目的】　プラズマと排ガスとの接触効率の問題と、スケールアップの問題とを同時に解決したプラズマ法排ガス浄化装置を提供する。

【構成】　放電電極13および対向電極14を備えた反応器10と、両電極13,14 に接続された高電圧パルス電源12とを備えている。両電極13,14 間には、高電圧パルスが印加されることにより非平衡プラズマ 21 が発生している。放電電極13は、対向電極14と同じ面積の支持板15と、支持板15下面に設けられた下向きの多数の放電針16とよりなる。支持板15には、多数の排ガス流入孔31が設けられている。支持板15から対向電極14に向かう排ガス流路30は、プラズマ21の進展方向と平行となっている。



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【特許請求の範囲】

【請求項１】　煙道の内部に放電電極および対向電極が設けられてなる反応器と、両電極に接続された高電圧パルス発生電源とを備え、両電極間に高電圧パルスを連続的に印加することにより非平衡プラズマを発生させ、被処理排ガスが反応器中を通過する間に排ガス中の有害ガス成分を捕集しやすい形態もしくは無害な形態に転換するプラズマ法排ガス浄化装置において、放電電極が、支持板と、支持板に設けられた複数の先端が尖った放電針とよりなり、支持板に被処理排ガスの流入孔が設けられ、支持板から対向電極に向かう排ガス流路が形成されていることを特徴とするプラズマ法排ガス浄化装置。

【請求項２】　放電電極および対向電極が交互に複数対設けられ、各対向電極に処理済み排ガスの流出孔が設けられている請求項１記載のプラズマ法排ガス浄化装置。

【請求項３】　放電電極および対向電極が交互に複数対設けられ、各対向電極が網目状の電極よりなる請求項１記載のプラズマ法排ガス浄化装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、発電用ボイラ、各種燃焼機関、燃焼炉等から排出される排ガス中に含まれる有害物質を浄化する手段の１つであるプラズマ法排ガス浄化装置に関する。

【０００２】

【従来の技術】プラズマ法排ガス浄化装置は、公知のものであり（公表特許公報昭６３－５００００２０号公報参照）、この原理を図５を参照して説明する。

【０００３】図５において、(1) はプラズマを発生させるための高電圧パルス発生電源を示し、(2) はワイヤ型放電電極、(3) はプレート型対向電極を示す。この両電極(2)(3)間にパルスピーク電圧１ｋＶ～５００Ｋｖ、パルス周波数１０ＨＺ～２５０ＨＺ、パルス幅１ナノ秒～１０マイクロ秒、立ち上がり時間１００ｋＶ／ナノ秒～１００Ｖ／ナノ秒の高電圧パルスを連続的に印加すると、電極間に非平衡プラズマ(4) が発生する。このような場に有害ガス成分を含む排ガス(5) を通じるとプラズマ(4) によって各種ラジカルが発生する。

【０００４】排ガス中の有害成分はこのラジカルとの反応によりＣＯはＣＯ$_2$に、ＳＯｘはＳＯ$_3$に、ＮＯｘはＮＯ$_2$に酸化され、無害な形態あるいは捕集されやすい形態に変化する。また、被処理ガスがごみ焼却炉からの排ガスの場合、ガス中に含まれるダイオキシンなどは分解されて無害化される。これらの反応が生じている反応器内、あるいは反応器後流にアンモニア、石灰等を吹き込むとＳＯｘ成分およびＮＯｘ成分はそれぞれ硫酸アンモニウムおよび硝酸アンモニウムまたは硫酸カルシウムおよび硝酸カルシウム等の固体に変化するので、後流に電気集塵器あるいはバグフィルターを設けてこれらを捕集することにより排ガス浄化が達成される。

2

【０００５】図６は、電極の変形例を示すもので、高電圧パルス発生電源(6) から、ワイヤ放電電極(7) とシリンダー電極(8) に高電圧パルスを連続的に印加して、両電極(7)(8)間にプラズマ(9) を発生させるタイプのものである。排ガス(5) はワイヤ放電電極(7) とシリンダー電極(8) との間に流される。

【０００６】

【発明が解決しようとする課題】上記の図５に示したワイヤ型放電電極とプレート型対向電極とを使用するものでは、排ガスの通過方向にプレートを長くするとともにワイヤを多数本設置することにより１つの電極ユニットを形成し、この電極ユニットを通過方向と直角方向に複数配置することによりスケールアップが可能であり、大量の排ガス処理ができるという利点を有しているが、ワイヤの長さ方向に間欠的にプラズマが発生する特徴を持つので、発生するプラズマに疎の部分ができてプラズマと排ガスとの接触効率が良くないと言う問題を有している。

【０００７】また、上記の図６に示したワイヤ型放電電極とシリンダー型対向電極とを使用するものでは、プラズマと排ガスとの接触効率は良いが、電界強度が小さいため、大量の排ガスを処理するためには、小口径のシリンダーを多数本配置する方法を取らなければならず、各電極の配線と絶縁が複雑化するのでスケールアップに適していないという問題がある。

【０００８】本発明の目的は、プラズマと排ガスとの接触効率の問題と、スケールアップの問題とを同時に解決したプラズマ法排ガス浄化装置を提供することにある。

【０００９】

【課題を解決するための手段】本発明によるプラズマ法排ガス浄化装置は、煙道の内部に放電電極および対向電極が設けられてなる反応器と、両電極に接続された高電圧パルス発生電源とを備え、両電極間に高電圧パルスを連続的に印加することにより非平衡プラズマを発生させ、被処理排ガスが反応器中を通過する間に排ガス中の有害ガス成分を捕集しやすい形態もしくは無害な形態に転換するプラズマ法排ガス浄化装置において、放電電極が、支持板と、支持板に設けられた複数の先端が尖った放電針とよりなり、支持板に被処理排ガスの流入孔が設けられ、支持板から対向電極に向かう排ガス流路が形成されていることを特徴とするものである。

【００１０】支持板上における放電針の存在密度は、放電電圧、電流、排ガス中のダスト濃度、排ガスの性状等を考慮して決められるが、通常、０．１～１０本／平方ｃｍ程度である。放電針の長さも放電電圧、電流等の諸条件によって任意に設計されるものであるが、通常は０．１ｃｍから１０ｃｍの間の値が採用される。

【００１１】支持板に設ける排ガスの流入孔の大きさおよび数は、流入孔の面積の和が排ガス導入パイプの断面積以上となるように決められる。流入孔の形状は、丸孔

であっても長孔であってもよい。

【００１２】放電電極および対向電極が交互に複数対設けられ、各対向電極に処理済み排ガスの流出孔が設けられていることが好ましい。排ガス流出孔の大きさおよび数は、放電電極の支持板に設ける排ガス流入孔の大きさおよび数と同様にして決められる。

【００１３】放電電極および対向電極が交互に複数対設けられ、各対向電極が網目状の電極よりなるようにしてもよい。

【００１４】

【作用】本発明によるプラズマ法排ガス浄化装置は、放電電極が、支持板と、支持板に設けられた複数の先端が尖った放電針とよりなるものであるから、プラズマに疎の部分ができないように放電針の密度を調整し、スケールアップするさいは、支持板の面積を大きくする。また、支持板に排ガスの流入孔が設けられ、支持板から対向電極に向かう排ガス流路が形成されているから、発生するプラズマの進展方向が排ガスの流れと平行となり、しかも、発生するプラズマの進展速度は排ガスの流れよりも速いから、排ガスは多段的にプラズマと接触する。

【００１５】

【実施例】本発明の実施例を、以下図面を参照して説明する。

【００１６】図１は、本発明によるプラズマ法排ガス浄化装置の第１実施例を示し、図２はそのプラズマ発生用電極の概念を示す。

【００１７】第１実施例のプラズマ法排ガス浄化装置は、煙道(11)の内部に放電電極(13)および対向電極(14)が設けられてなる反応器(10)と、両電極(13)(14)に接続された高電圧パルス電源(12)とを備えている。

【００１８】反応器(10)の左側壁の上端部に被処理排ガス(18)の導入パイプ(19)が、同下端部に処理済み排ガス(33)の排出パイプ(20)が設けられている。放電電極(13)は反応器(10)の上部に水平に配置され、放電電極(13)の上方が排ガス導入空間となされている。対向電極(14)は反応器(10)の底壁を形成しており、放電電極(13)と反応器(10)とは、絶縁用セラミック(32)によって電気的に絶縁されている。

【００１９】対向電極(14)はプレート型であり、放電電極(13)は、対向電極(14)と同じ面積の支持板(15)と、支持板(15)下面に設けられた下向きの多数の放電針(16)とよりなる。放電電極(13)の支持板(15)には、多数の排ガス流入孔(31)が設けられており、これにより、支持板(15)から対向電極(14)に向かう排ガス流路(30)が形成されている。

【００２０】放電電極(13)は、良好な導電性材料からなり、放電針(16)の先端部は０．１ｃｍ～１ｃｍの直径を有している。放電針(16)の基端部の直径は任意であるが、その先端部は尖っているほうが好ましい。放電針(16)の先端部を尖った形状とすることにより、電界強度を大きくすることができる。支持板(15)上における放電針(16)の存在密度は、放電電圧、電流、被処理排ガス(18)中のダスト濃度、被処理排ガス(18)の性状等を考慮して決められるが、通常、０．１～１０本／平方ｃｍ程度である。放電針(16)の長さも放電電圧、電流等の諸条件によって任意に設計されるものであるが、通常は０．１ｃｍから１０ｃｍの間の値が採用される。

【００２１】支持板(15)に設ける排ガス流入孔(31)の大きさおよび数は、流入孔(31)の面積の和が排ガス流入パイプ(19)の断面積以上となるように決められる。このようにすることにより、排ガス(18)が排ガス流入孔(31)を通過するさいに抵抗損失が発生することが防止される。流入孔(31)の形状は、丸孔であっても長孔であってもよい。

【００２２】ＮＯｘとＳＯｘを含む被処理排ガス(18)は、流入パイプ(19)から反応器(10)中に入り、支持板(15)の排ガス流入孔(31)を通り、両電極(13)(14)間の排ガス流路(30)を放電針(16)と平行に下向きに流れ、無害化処理される。処理済みの排ガス(33)は流出パイプ(20)より反応器(10)外に排出される。

【００２３】放電電極(13)と対向電極(14)との間には、高電圧パルスが印加されることにより非平衡プラズマ（パルスストリーマコロナ）(21)が発生している。被処理排ガス(18)は反応器(10)中の排ガス流路(30)を通過する間にプラズマ(21)と接触し、これにより排ガス中に各種ラジカルが発生する。このラジカルによって排ガス中のＮＯｘとＳＯｘは酸化されて、NO_2とＳＯ３に変化する。このように変化した有害ガス成分を含む処理済み排ガス(33)は流出パイプ(20)を通って後流に設けた捕集部（図示略）に移動する。発生するプラズマ(21)の進展方向は、排ガス流路(30)の方向と平行であるから、たえず排ガス(18)とプラズマ(21)とが接触し、処理効率が向上する。さらに、発生するプラズマ(21)の進展速度は、排ガス流路(30)における排ガスの流れよりも速いから、処理される排ガスは多段的にプラズマ(21)と接触して解離が起こり、より一層処理効率が向上する。

【００２４】図１には図示していないが、NO_2およびＳＯ３などのガスはアルカリ性の物質例えばアンモニアあるいは消石灰と極めて良く反応するのでダクトを出た後、捕集部において例えば次のような方法によってガス中から除去される。

【００２５】①ガス中にアンモニアを吹き込むことによって、硝酸アンモニウムと硫酸アンモニウムを生成させ、さらに後流に設けた電気集塵機もしくはバグフィルターで捕集する。

【００２６】②ガス中に消石灰を吹き込むことによって、硝酸カルシウムと硫酸カルシウムを生成させ、さらに後流に設けた電気集塵機もしくはバグフィルターで捕集する。

【００２７】③湿式洗煙塔に導き、石灰スラリーあるい

は水酸化ナトリウム水溶液で洗浄してガス中から除く。

【００２８】なお、上記において、排ガス中のＮＯｘをNO_2とする例について説明したが、条件によりＮＯｘはN_2となる場合がある。排ガス中にアンモニア、炭化水素などの還元剤を共存させると、N_2への転換が著しくなる。この場合、上記実施例とは逆に還元剤を先に吹き込んだ後、反応器を通過させることになるが、この場合でも本発明による効果は変わらない。

【００２９】図３は本発明によるプラズマ法排ガス浄化装置の第２実施例を示している。第２実施例のプラズマ法排ガス浄化装置では、反応器(10)内に、放電電極(13)および対向電極(14)が交互に複数対設けられている。放電針(16)は放電電極(13)の支持板(15)の両面に設けられ、両端の電極はいずれも対向電極(14)となされている。放電電極(13)の支持板(15)には、第１実施例と同じく、多数の排ガス流入孔(31)が設けられており、対向電極(14)には、多数の処理済み排ガス流出孔(32)が設けられている。

【００３０】放電電極(13)と反応器(10)外壁とはセラミック製の絶縁体によって電気的に絶縁されている。高圧パルス電源(12)と各電極(13)(14)とをつなぐ導線(17)も同様に反応器(10)外壁と絶縁されている。

【００３１】対向電極(14)に設ける流出孔(32)の大きさおよび数は、放電電極(13)の支持板(15)に設ける流入孔(31)の大きさおよび数と同様にして決められる。

【００３２】第２実施例の装置では、導入パイプ(19)から反応器(10)中に導入された被処理排ガス(18)は、各放電電極(13)の支持板(15)の排ガス流入孔(31)および各対向電極(14)の排ガス流出孔(32)を順次通って両電極(13)(14)間を放電針(16)と平行に流され、すべての電極(13)(14)間を通る間に無害化処理される。処理済みの排ガス(33)は排出パイプ(20)より反応器(10)外に排出される。

【００３３】したがって、導入から排出までの間に、被処理排ガス(18)がプラズマ(21)と接触する時間が非常に長くなり、排ガスは極めてきれいに無害化処理される。

【００３４】図４は本発明によるプラズマ法排ガス浄化装置の第３実施例のプラズマ発生用電極の概念を示している。

【００３５】第３実施例のプラズマ法排ガス浄化装置のプラズマ発生用電極は、第１実施例と同じ放電電極(13)と、網目状の対向電極(34)とよりなる。そして、放電電極(13)の支持板(15)から対向電極(34)に向かう排ガス流路(30)が形成されている。これらの電極(13)(33)は、図３に示した第２実施例のプラズマ法排ガス浄化装置と同じく、交互に複数対設けられる。

【００３６】第３実施例の装置では、被処理排ガス(18)は、各放電電極(13)の支持板(15)の排ガス流入孔(31)および各対向電極(33)の網目の間を順次通って両電極(13)(33)間を放電針(16)と平行に流され、すべての電極(13)(33)間を通った後、排出される。したがって、導入から排出までの間に、排ガス(18)がプラズマ(21)と接触する時間が非常に長くなり、排ガスは極めてきれいに無害化処理される。

【００３７】

【発明の効果】本発明のプラズマ法排ガス浄化装置によると、プラズマに疎の部分ができないように放電針の密度が調整できるので、プラズマと排ガスとの接触効率が良い。しかも、発生するプラズマの進展方向が排ガスの流れと平行でかつ排ガスは多段的にプラズマと接触するので、排ガスとプラズマとの接触時間が十分得られ、処理効率が向上する。また、スケールアップするさいは、支持板の面積を大きくすればよいので、容易にスケールアップができる。

【図面の簡単な説明】

【図１】本発明によるプラズマ法排ガス浄化装置を概略的に示す垂直断面図である。

【図２】同装置におけるプラズマ発生用の電極の概念を示す斜視図である。

【図３】本発明によるプラズマ法排ガス浄化装置の他の実施例を概略的に示す一部を切欠いた斜視図である。

【図４】プラズマ発生用の電極の他の実施例の概念を示す斜視図である。

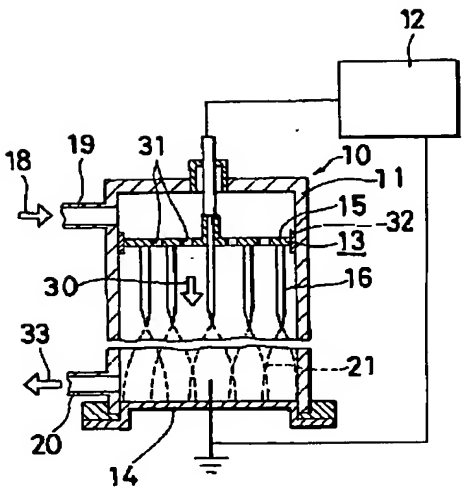
【図５】従来のプラズマ法排ガス浄化装置におけるプラズマ発生用の電極の概念を示す斜視図である。

【図６】従来のプラズマ法排ガス浄化装置におけるプラズマ発生用の電極の概念を示す斜視図である。

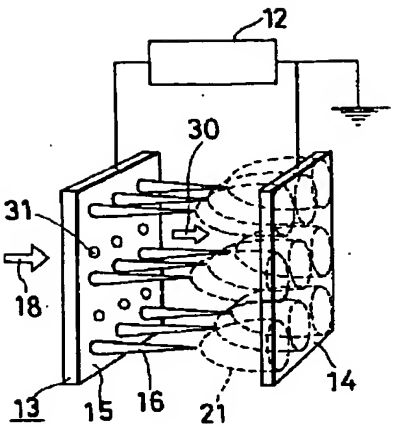
【符号の説明】

(10)　反応器
(11)　煙道
(12)　高圧パルス電源
(13)　放電電極
(14)(34)　対向電極
(15)　支持板
(16)　放電針
(18)　排ガス
(21)　プラズマ
(30)　排ガス流路
(31)　排ガス流入孔
(32)　排ガス流出孔

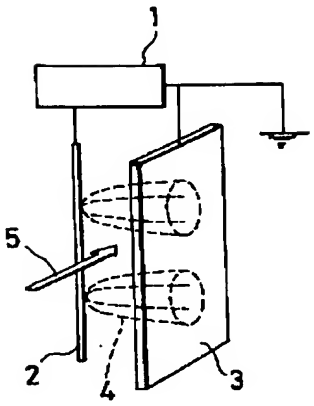
【図１】



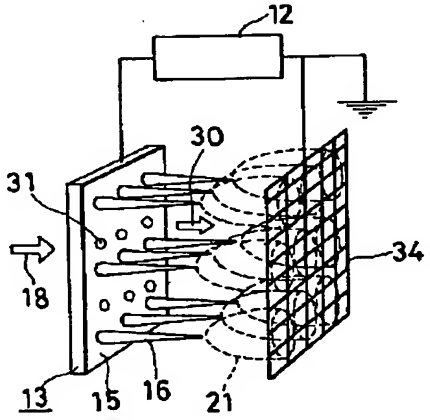
【図２】



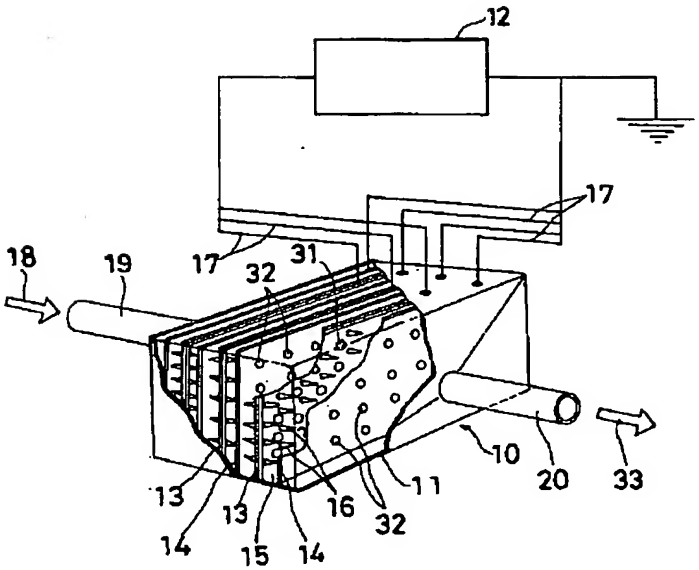
【図５】



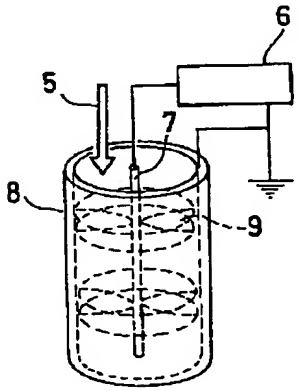
【図４】



【図３】



【図６】



フロントページの続き

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